238687

MAINTENANCE MANUAL

FM UNIVERSAL RECORD CHANNEL "MC"

Specifications are subject to change due to contineous development

BELL & HOWELL

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MC HM-E
1179

FM
Universal Record Amplifier
"MC"

Table of Contents

1. General Description
1-1. Equipment Description
1-2. Performance Characteristics

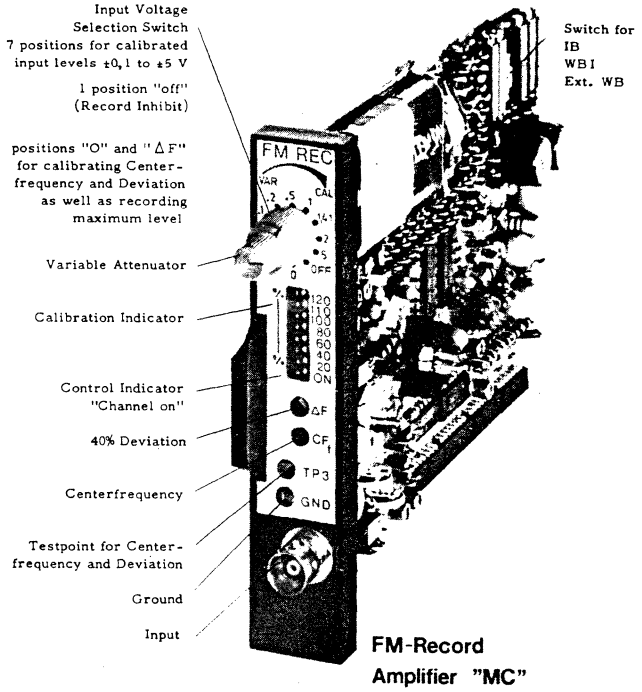
2. Installation
2-1. General
2-2. Amplifier Card Preparation
2-3. Amplifier Card Installation and Removal Caution

3. Operation

4. Theory of Operation
4-1. General
4-2. Explanation of the "MC"
4-3. Detailed Explanation of Functions

5. Calibration and Maintenance
5-1. Preventive Maintenance
5-2. Head Current
5-3. Calibration and Adjustment of the "MC"
5-4. Repair
5-5. Parts Identification
5-6. Field Repair Service
5-7. Factory Repair Service
5-8. Recalibration of the Circuit Card after Repairing with Spare Parts

6. Parts Lists
6-1. General
6-2. Ordering Replacement Parts



FM-Record Amplifier "MC"

1. General Description of the FM Universal Record Amplifier "MC"

For FM recording the measurement data signal is transformed into a frequency-time signal prior to recording onto the data track of the magnetic tape unit. A voltage-controlled oscillator (VCO) is modulated in synchronization with the measured signal. The resulting carrier-frequency signal is then transferred to the magnetic tape via the record head.

This track, magnetized in synchronization with the carrier and its frequency modulation is read by the reproduce head. The voltage induced in the reproduce head is amplified and output. This signal is subsequently demodulated, the residual carrier suppressed by filters, and the signal passed to the output.

This procedure allows a broad dynamic range since the amplitude limits are not determined by the saturation of the magnetic tape.
Additional advantages include:
linearity, which is determined predominantly by the modulator and demodulator;
lesser number of interruptions due to magnetic head contact problems (dropouts);
expansion of the frequency band being transmitted to include low frequencies down to d.c. whose stable transmission is determined by the stability of the tape deck and of the capstan rpm (band flutter).

1-1. Equipment Description

The high impedance input (1 MΩ) can be connected to a broad range of signal sources.

The input attenuator determines calibrated input sensitivities from ± 0.1 V to ± 5 V with locked potentiometer (cal). 1.41 V is equivalent to 1 Vrms for sinusoidal signal voltages.

In the OFF position (Aus) the head driver is de-energized. No data are recorded on the corresponding track.

The channel is prepared for recording by selecting the desired input sensitivity on the attenuator.

The ON lamp lights up only when the system records and when the head current flows (not when the attenuator is set to OFF).

The amplitude can be monitored on the indicator lamp even when the tape deck is stopped in order to match it to the measurement signal.

The indicator stages refer to modulation percentages, referred to the voltage selected on the attenuator; 100 % is equivalent to ± 40 % frequency deviation of the FM system.

When the measured signal is matched by means of the potentiometer the input sensitivity decreases with increasing value selected on the attenuator.
The modulation is verified by means of the indicator lamps and adjusted to signal maximum, or positive or negative polarity, until the 100 % lamp lights up.

The operating mode (IB, WB, ext. NB) can be selected after pulling the circuit card.
Caution: the tape unit must be turned off when circuit cards are pulled or plugged in.

In order to be able to identify the mode of operation on the tape it is best to use the reference on the MC card to record the mode on the tape.
Prior to signal recording the unit is briefly set to switch position "O" and subsequently to "+ΔF" to record the identification on the tape.

During reproduction this will provide the zero line and the maximum positive modulation (+1.41 V).

1-2. Performance Characteristics

FM record amplifier card, Type MC.
Designed for 9 center frequencies (including a frequency deviation of ±40 %), switched electrically together with the tape speed.
The desired frequency band - IB, WBI or ext. WB - can be selected on the circuit card.
Also refer to the tables on band width and signal-to-noise ratio.

Input voltage ranges	Selectable by means of rotary selector switch at the following increments (tolerance ±0.5 %):
±0.1 V ±0.2 V ±0.5 V ±1.0 V ±1.41 V ±2.0 V	infinitely variable fine adjustment (knob) can be used to increase any nominal value to 3 times its original value; in that case the next-following value is overlapped.
±5.0 V	can be increased up to ±10 V via fine adjustment

Overdrive protection	±20 V
Input impedance	1 MΩ to ground
Output voltage	The output voltage to the record head can be adjusted from 0...50 mA.
Selective track disable	When the rotary selector switch is in the OFF position the output current to the record head is de-energized; the amplifier itself remains energized and always operational. This feature allows track-by-track recording.

Modulation display

Modulation percentage on the input side	The following light up: LED	Color
Connected channels:	1	Green
≥ 20 %	1 and 2	Green
≥ 40 %	1 to 3	Green
≥ 60 %	1 to 4	Green
≥ 80 %	1 to 5	Green
≥ 100 % *	1 to 6	Green
≥ 110 %	1 to 7	Green + Yellow
≥ 120 %	1 to 8	Green + Yellow + Red

* ±3 % indicating tolerance - this value is referred to full modulation at ±40 % frequency deviation

Reference signals	Center frequency	in position "0"
	Center frequency with +40 % deviation	in position "ΔF"

In both positions of the rotary selector switch the measured signal input is disconnected and the selected reference signal recorded on the tape track.
Advantage: during subsequent signal evaluation the signal modulation percentage which has been achieved and the occurrence of overdriven phases can be clearly determined.

Carrier offset

Where signals with only one polarity must be recorded the center frequency can be "displaced" by as much as +40 % or -40 % of its value in order to utilize the full dynamic range.

Power requirement	+15 V	150 mA
	-15 V	100 mA
	+5 V	20 mA

2. Installation

2-1. General

This section contains the installation procedures for the MC Universal FM Record Amplifier. If this is an initial installation, refer to Section V for calibration procedures.

2-2. Amplifier Card Preparation

Prior to installation, visually inspect the circuit card for input damage, loose parts, moisture, corrosion, dust and for any other condition which may impair the life of the amplifier or otherwise degrade its performance. Ensure that the shield is in place. See Section V for repair and maintenance instructions before poceeding with repairs.

2-3. Amplifier Card Installation and Removal Caution

Turn system power OFF before installing or removing amplifier cards from the amplifier case assembly.

The FM record amplifier circuit card is positioned by guide slots in the record section of the amplifier case assembly. The record section consists of the first seven positions. The amplifier circuits are numbered from left to right and correspond to channel numbers.

IRIG Intermediate Band ± 40% Deviation

TAPE SPEED	BANDWIDTH (kHz ± 0.5 dB)	CENTER FREQUENCY
120 ips	0-40	416 kHz
60 ips	0-20	108 kHz
30 ips	0-10	54 kHz
15 ips	0- 5	27 kHz
7,5 ips	0- 2,5	13,5 kHz
3,75 ips	0- 1,25	6,75 kHz
1,875 ips	0- 0,625	3,375 kHz
0,9374 ips	0- 0,312	1,687 kHz

IRIG Wideband Group I ± 40% Deviation

TAPE SPEED	BANDWIDTH (kHz ± 0.5 dB)	CENTER FREQUENCY
120 ips	0-80	432 kHz
60 ips	0-40	216 kHz
30 ips	0-20	108 kHz
15 ips	0-10	54 kHz
7,5 ips	0- 5	27 kHz
3,75 ips	0- 2,5	13,5 kHz
1,875 ips	0- 1,25	6,75 kHz
0,9375 ips	0- 0,625	3,375 kHz
0,4687 ips	0- 0,312	1,687 kHz

B. u. H. Extended Wideband Group I ± 40% Deviation

TAPE SPEED	BANDWIDTH (kHz ± 0,5 dB)	CENTER FREQUENCY
60 ips	0-80	432 kHz
30 ips	0-40	216 kHz
15 ips	0-20	108 kHz
7,5 ips	0-10	54 kHz
3,75 ips	0- 5	27 kHz
1.875 ips	0- 2,5	13,5 kHz
0,9375 ips	0- 1,25	6,75 kHz
0,4687 ips	0- 0,625	3,375 kHz

With the circuit card positioned in a guide slot, all electrical connections are completed when the connector end of the circuit card is mated with its respective connector on the amplifier mother board. The mother board is located in the amplifier case assembly.

The input is normally obtained through a BNC connector located on the lower front of the circuit card. The area immediately surrounding the BNC connector is color coded to identify the type of circuit card. The FM record amplifier is identified by a black color.

The amplifier card should be removed from the amplifier case assembly in the following manner: using the black handle attached to the front panel, firmly pull the card forward until the connector pin clears the connector socket and guide slots.

3. Operation

In the stand-by mode the ON LED is disconnected. In the recording mode and when the sensitivity has been selected this LED will light up green.
If the attenuator is in the OFF position this LED remains disconnected even while recording. No data are recorded on the track in question and the carrier is disconnected. Signal cables may remain connected to the BNC input jack (the input impedance of 1 MΩ remains effective).

In both, the stand-by and the record modes, the LED display will indicate input signals when the attenuator is set to an input voltage stage (±0.1 V...±5 V). Thus, matching via selection of the suitable input voltage stage can be accomplished when the tape deck is stopped.

The display processes positive and negative voltages in one indicating direction, including the d.c. voltage component.
In the carrier offset mode the display remains unchanged (the signal levels must be adjusted by selecting a suitable frequency deviation on external equipment).

The variable attenuator can be adjusted with the aid of the LED display when the input signal has been connected. The knob will lock in the calibrated position. From that point on the calibrated data of the adjusted attenuator apply.

Prior to recording it is best to record briefly with the attenuator first set to the 0 position and subsequently to the $+\Delta F -$ position.
This setting can be used to verify the reproduce calibration (RC or RC 9). In addition, a tape leader of this type can be used to verify the proper setting of the mode of operation (IB, WB, ext.WB) on the reproduce side. Erroneous settings will result in an offset signal on the reproduce side.

4. Theory of Operation

4-1. General

The frequency modulation method of magnetic tape recording causes data to be recorded on tape in the form of variations in frequency about a center frequency. The amount of frequency deviation from the center frequency is determined by the amplitude of the data signal. The rate at which the frequency to be recorded varies about the center frequency is determined by the frequency of the data signal. At the positive excursions of the input data signal, the signal to be recorded will be of

a higher frequency than the center frequency. At the negative excursions of the input data signal, the signal to be recorded will be of a lower frequency than the center frequency.

4-2. Explanation of the "MC"

The input stage consists of an impedance transformer. The input impedance is 1 MΩ. The variable attenuator, which reduces the sensitivity range selected by approximately 3 times, is connected at the output of this stage. For instance, cal = 1 V can be attenuated to 3 V. The selector has a lock which has the result that the signal passes calibrated through the first two stages. The input of the integrated amplifier has a protective circuit which allows continuous overloading up to ±20 V.

The switchable gain amplifier includes incremental fixed resistances for the range from ±0.1 V to ±5 V, which pass the feedback signal to the inverted input via the range selector switch, allowing switchable gain (no attenuator). This resistor arrangement is compensated by capacitors. In this stage the same range selector switch is used to disconnect the input stage ("0" and "OFF"). In the "0" position the zero potential, a reference, can be recorded without the necessity of disconnecting the signal sources. In the "+ΔF" position an internal reference voltage is input into this stage which is equivalent to the positive 40 % frequency deviation. This voltage is used for calibrating the system and for recording a positive reference on the tape for verification on the reproduce side.

Adder Stage

In the adder stage the signal, the "coarse" setting of the center frequency and a constant potential required for operating the VCO are summed. This feature allows independent selection of the frequency deviation and the center frequency. The center frequency setting range has been selected so that operation with plus or minus frequency deviation is possible as a basic setting in the case of measured signals having only one polarity. The advantage of this special setting is that the full dynamic range of the FM record system can be utilized.

Voltage-Controlled Oscillator

The basic VCO circuitry includes a multivibrator. The operating voltage for the significant functions is derived from the internal reference. Control voltage input from the adder stage is accomplished via d.c. sources in order to achieve good linearity. Fine adjustment of the center frequency is accomplished together with operating voltage adjustment. A starter circuit initiates the oscillator when the unit is turned on.
Caution: in the event of malfunctions wait 5 seconds before turning the unit on again.

The frequency range is selected in the control circuit. The signals arriving on the speed lines from the magnetic tape unit and the operating modes IB, WB, ext. WB are combined so that the output of the correct center frequency is accomplished automatically.

The head driver feeds three potentiometers which are connected to record head output by the IB/WB/ext. WB mode selector switch. This allows selection of the optimum record head current for the operating mode in question.

A two-phase rectifier rectifies the measured signal, passing its d.c. component. As a result, both signal polarities are prepared for indication in one direction.

The comparator divides the rectified signal into 7 voltage levels.

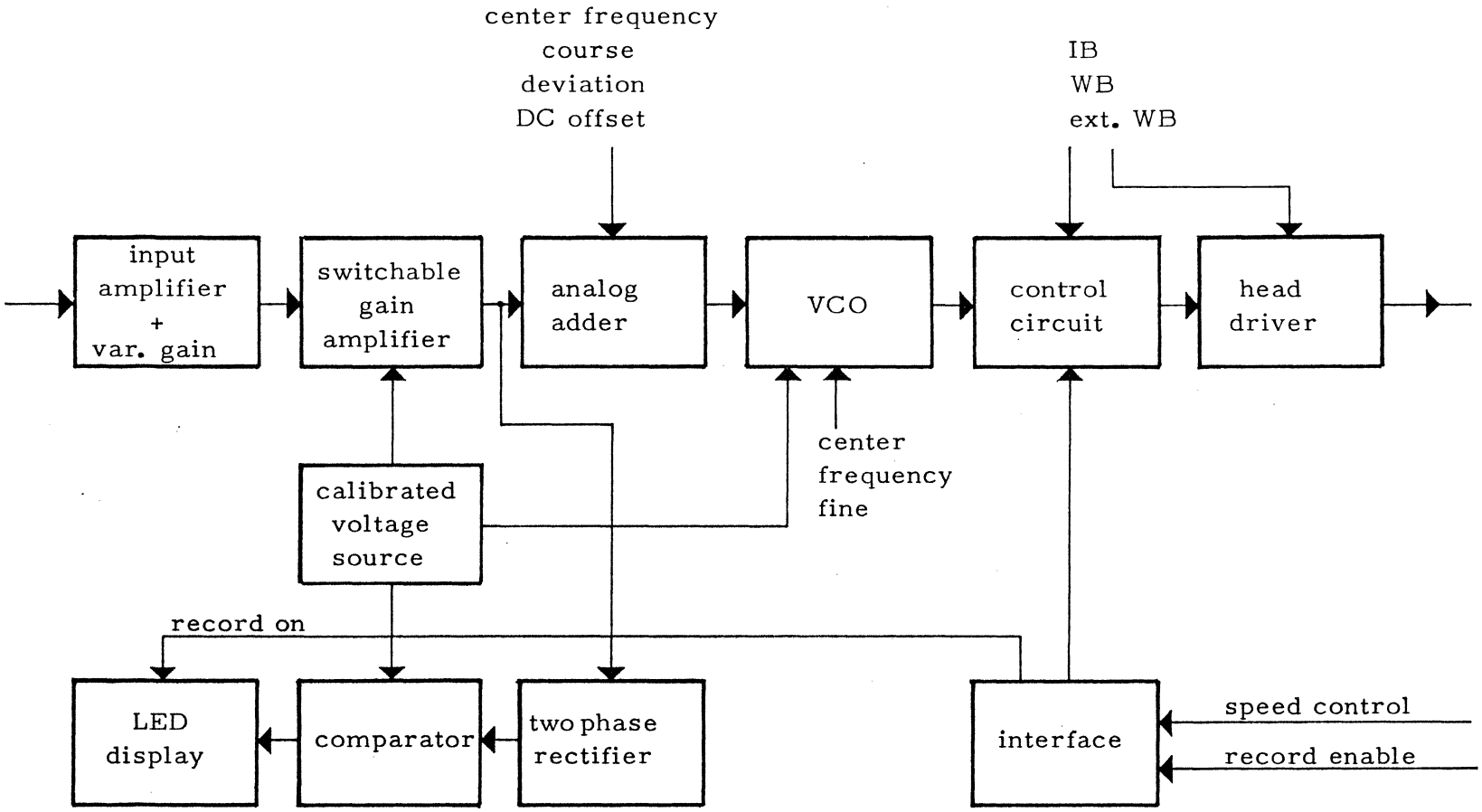
The display is connected in series to conserve power. The power requirement is controlled by a power source independently of the number of LED's which are illuminated.

The calibrated voltage source with stabilizer circuit supplies the VCO and the display, and allows system calibration without external voltage source.

The interface matches the tape unit level arriving on the speed lines and the CMOS level, and protects the inputs.

4-3. Detailed Explanation of Functions

The input signal passes the protective circuit formed by R2, D1, D2, D3, D4. The IC 1 amplifier is connected as an impedance transformer. The feedback R7 is part of the protective circuit. R7 is bypassed via C1 for dynamic gain determination (V = 1).



Block Diagram of the
FM Record Amplifier, Modulator
"MC"

Caution:
The amplifier inputs are MOS gates. The built-in protective diodes are not sufficient for all operating conditions, therefore observe the following: always protect the equipment and the operator against static charges and prior to working with the equipment discharge against the grounded equipment housing. The same applies when handling the card with the digital MOS-IC's.

R6 is used for the zero calibration of the input offset voltage. The output passes via a coax cable to the variable attenuator potentiometer R3. This pot is mounted on the attenuator switch bracket. The signal from this pot is passed to the attenuator switch S1a. At this point the input stage is disconnected from the remaining circuitry when the switch is in the OFF, ΔF or CF position. The diodes D1 and D2 are light-protected in order to prevent voltage error due to light exposure when the unit is operated with open cover and during calibration work.

The switchable gain amplifier includes IC 2, switch S1b and the resistance of the voltage divider. The amplifier is compensated so that the compensating capacitors are connected in series with C 48 via the voltage divider. This circuitry ensures a band width of 80 kHz in steady state operation. The voltage divider is dimensioned so as to eliminate matching of compensating capacitors. R 13 is used for zero calibration of the input offset voltage of the IC. The output leads to three units.

The signal is passed from IC 2 via R 64 and R 65 to IC 3, the adder stage. R 64 is used to select the modulation frequency deviation. The node at the input IC 3 - 2 of this stage is passed to zero by input IC 3 - 3 which is connected to ground. As a result the coarse settings of frequency deviation and center frequency are independent of R 71. In addition, a constant current is added via R 68 which provides the VCO with its operating point. When point PR 2 is short-circuited to ground and when the input voltage is zero volts, the output of IC 3 - 6 carries +0.8 to 0.9 V d.c. When the center frequency is selected via R 71 (PR 2 is open), the voltage is +1.0 to 1.6 V.

The voltage to frequency converter is a VCO (voltage-controlled oscillator). The basic circuitry includes a multivibrator consisting of T5 and T6. C 19 to C 22 are mica capacitors. The reference voltage is passed to the VCO via d.c. sources T7 and T8. The diode D 20 compensates the temperature deviation of T7 and T8. The supply voltage is generated separately from the reference and passed to C 23/24. 1/2 IC 4 is used as the voltage controller. R 83 is used to select the supply voltage and, at the same time, achieve fine center frequency adjustment. The voltage applied to C 23/24 is approximately -7 V. Diodes D 17, 18, 19, 21 limit the oscillation amplitude and are used for frequency stabilization.
When the unit is turned on, the starter circuit D 70, C 50, R 180 blocks T6. The oscillator circuit can be started when C 50 has been recharged by the power source. R 181 and 182 provide the initial conditions prior to turning on the unit. When the unit is turned off at least five seconds must pass before it can be turned on again.

T3 is used to decouple the VCO from the logic and serves as a level transformer. This circuit is dimensioned so that a symmetrical square wave results. This condition must be verified in the event of repairs because 432 kHz is used as the VCO frequency and, at the same time, as the carrier for 80 kHz FM. Any duty factor error on the level transformer means a distortion factor in the data channel.

The control circuitry includes the operating mode input S2b, IC 14 and the speed information input IC 7, 8, and part of IC 9. The voltage dividers in IC 6 are connected depending on the switch position of S2b. In the ext. WB operating mode the carrier frequency is passed via IC 4 directly to the switch IS 7 or to the main voltage divider IC 5. In the WB 1 operating mode 1/2 of IC 6 is connected as a divider between the level transformer and the main voltage divider. In the IB operating mode both dividers IC 6 are connected in the chain. Depending on the speed selected, one stage of divider IC 5 is connected via the corresponding gate and via the diode coupling field D 57 to D 60 to the main gate IC 9. The main gate IC 9 obtains the ON - OFF information from the attenuator switch and, via T1, the record enable information from the tape unit. Resistances R 34 and R 35 supply the power for the logic states.

The head driver includes T9 and T 10. T 10 obtains a d.c. free supply via the network consisting of C 33, R 86 and D 23. C 34 is used to compensate the input capacitance of T 10. T9 operates in a boot-strap circuit controlled by T 10. C 35 and C36 prevent any residual d.c. component from reaching the record head output. R 92, 93 and 94 allow separate record head current selection for the three modes of operation

selected by means of S2a. The test signal is decoupled via R 97. R 98 limits the record head current in the event of operator errors. For the IB head groups it may be advisable to bypass R 98 by means of a hard-wired 10 µF capacitor to ensure that the record flow is achieved with a 432 kHz carrier.

From the IC 2 - 6 output the signal is passed to the two-phase rectifier consisting of IC 10 and IC 11. This circuit will pass the d.c. component. The second stage (IC 11) is connected to the diodes so that D 30 and D 31 compensate each other with respect to voltage drop and temperature deviation. C 39 and R 172 form a time constant for holding the information in the event of short pulses.

The comparator consists of 7 individual circuits, IC 12 and IC 13 which determine the levels of the LED display. The signal delivered by the rectifier ranges from 0 to -6 V (in the event of overdriving). The switching thresholds are determined by the voltage divider consisting of R 105, 112, 121, 131, 141, 151, 161. The voltage is derived from the reference by 1/4 IC 12. (On the circuit cards up to serial number 09010100 the threshold supply is generated directly from -15 V via R 170/R 171. On these circuit cards, R 171 is matched via hard-wired circuitry so that the indication is $+\Delta F$ = 100 % whenever the operating voltage deviates from a level of -15 V). For circuit cards from serial number 09020001, R 104 is used for calibration, keeping in mind that the 100 % LED should have a tolerance of $\pm$3 %; refer to Para. 5-8.

The display LED's D 40 to D 46 are connected in series and are supplied by the power source T 18, R 109. Transistors T 11 to T 17 are connected at input level. At that point the LED's are off. When the first comparator IC 13 is tripped by an input signal received from the rectifier the output voltage will pass to -15 V, T 11 will block, and LED D 40 will light up. In a similar manner the other display LED's operate at higher output voltages of the rectifier.
On the 100 %, 110 % and 120 % levels an additional RC combination is installed between comparator and transistor. This circuit will hold the indication on the display when these thresholds are exceeded only temporarily so that the normally operating time constant of C 39 and R 172 is not fully passed. This means that transients in the 100 % range and above are no longer indicated. The power consumption does not change with the number of LED's which are on. LED D 47 is the indicator for the current recording run. It is driven via T2. When the attenuator switch is in the OFF position the lamp and gate IC 9 are turned off. The location of this LED under the 20 % LED allows an easily visible reference point for the zero value of the indication.

The D 26 Zener diode is temperature-compensated and supplies the reference for the entire circuit card. 1/2 IC 4 is used to generate a precise voltage of 5 V which supplies the components. The 5 V calibration is accomplished by means of R 80. This calibration has been performed at the manufacturing plant, and recalibration should be perfomed only under exceptional circumstances (cf. Para. 5-8.). When the attenuator switch is set to ΔF the input of IC 2 is connected to this 5 V reference in order to adjust the plus deviation.

The control interface includes diodes D6 to D 14. The resistances and diodes are used as level transformers and to protect the CMOC IC's against erroneous voltages.

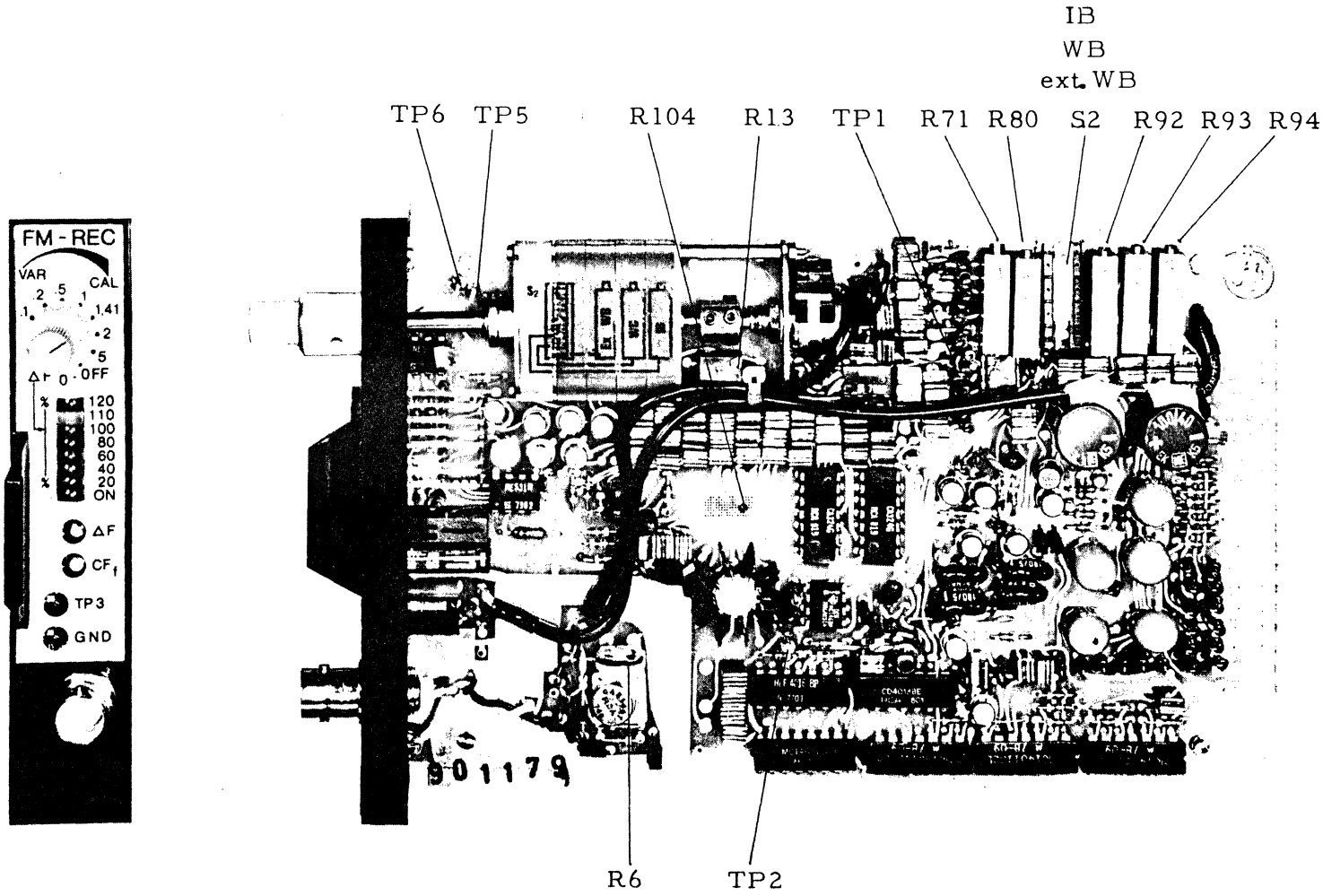
5. Calibration and Maintenance

5-1. Preventive Maintenance

Preventive maintenance consists of general cleaning and periodic inspection. Accumulation of dust, dirt, grit, and/or grease on the circuit boards is harmful and should be guarded against by periodic inspection and cleaning. Every six months, under normal laboratory conditions, inspect the units for signs of deterioration, loose connections, insecurity of mounting and foreign matter. The period of cleaning depends on the particular operation environment and should be determined by inspection. As necessary, clean the circuit board with a soft brush and/or low pressure air or vacuum, or suitable solvent, being careful not to damage the printed circuitry.

5-2. Head Current

Exact head current calibration is necessary to ensure optimum recording conditions. The MC circuit card has three separate potentiometers for the operating modes IB, WB, and ext. WB. The potentiometers are integrated automatically into the head circuit by means of the switching position of S2. Consequently, calibration is accomplished individually for each mode of operation to ensure optimum recording quality.



FM Universal Record Amplifier "MC"
Location of Controls and Test Points

In order to adjust the head current the MC circuit card required for the channel being used is plugged into the extender card and then plugged into the tape unit in the proper position. The potentiometers R 92 (for ext. WB), R 93 (for WB) and R 94 (for IB) are located on the circuit card next to the connector. Precise calibration requires a reproduce card (such as RC or RC 9) in the corresponding reproduce channel. An oscilloscope is connected to TP 1 and GND on the reproduce side. Using the record mode of operation, best at a tape speed of 71/2 ips, the head current is first adjusted in operating mode IB, using potentiometer R 94 until the measured amplitude at TP 1 on the reproduce side has reached a maximum. Counterclockwise rotation of the potentiometer will increase the head current. The same procedure is used to calibrate in operating mode WB, using potentiometer R 93. For tape units fitted with WB heads, operating mode ext. WB is used in conjunction with potentiometer R 92. It is not absolutely necessary to change the reproduce card, when only the relative carrier output voltage is measured.

When the entire electronics are tested the same mode of operation must be selected on the reproduce side. Fine calibration of the head current to optimize the signal-to-noise ratio via the tape is acceptable. A check on the record circuit board, using TP 3 against GND, is possible. When the circuit card is properly connected the amplitude will be 300 to 400 mV peak-to-peak. The voltage profile is rectangular.

5-3. Calibration and Adjustment of the "MC"

For calibrating the center frequency and the frequency deviation the tape unit, fully equipped in accordance with the measuring function desired, should have warmed up at least fifteen minutes in the STOP mode. The W calibrator, Type 12-455, with test cable is required for these measurements. Deviating from operating instructions No. 526200-8009 and the service letter dated 28.4.1978, the calibrator is used only as the receiver for the carrier frequency to be measured (CF = 54 kHz + ΔF = 75.6 kHz).

Tape speeds:

in operating mode	IB:	30 ips
in operating mode	WB:	15 ips
in operating mode ext.	WB:	71/2 ips

The test cable of the calibrator is used to connect TP 3 to the frequency input. The signal lines may remain connected to the MC input for this calibration.

The attenuator is set to zero. The calibrator is set to zero. With the calibrator in the test position or, when the tape is running in the record mode position, the carrier frequencies are adjusted to set the LED's to a minimum in accordance with the operating instructions for the calibrator. If the range of the pot on the front panel of the MC circuit card is inadequate, the card is pulled, a preliminary calibration on R 71 is made, using an extender card, and subsequently the carrier frequencies are calibrated (R 83) after plugging in the card. The attenuator is set to ΔF, and the calibrator is set to +40 %.
ΔF (R 64) is now calibrated on the front panel under the same conditions as cF.

Alternating recalibration is not required for the MC circuit card. A test of both settings is meaningful because offset errors may be present in amplifiers IC 1 and IC 2 in the event of calibration errors. Following this calibration the attenuator voltages are calibrated within the accuracy range of the circuit card when the variable attenuator is set to the cal position.

The MC circuit card can also be calibrated without this calibrator, provided that a frequency counter is available. The counter input is connected to TP 3 and GND. Using the table below, the coarse cF calibration (R 71),the fine cF calibration (R 83) and the ΔF calibration (R 64) can be performed, using the internal reference voltage of the MC circuit card (for a positive frequency deviation).

tape speeds IRIG IB	IRIG WBI	ext. WB	carrier frequency	carrier deviation plus 40%	minus 40%
(ips)	(ips)	(ips)	(kHz)	(kHz)	(kHz)
-	120	60	432	604.8	259.2
120	60	30	216	302.4	129.6
60	30	15	108	151.2	64.8
30	15	7 1/2	54	75.6	32.4
15	7 1/2	3 3/4	27	37.8	16.2
7 1/2	3 3/4	1 7/8	13.5	18.9	8.1
3 3/4	1 7/8	15/16	6.75	9.45	4.05
1 7/8	15/16	15/32	3.375	4.725	2.025
15/16	15/32	-	1.688	2.363	1.013

If it is intended to record measured signals with one polarity only the full dynamic range of the MC can be utilized by offsetting the center frequency while recording. In that case a corresponding calibration must be accomplished on the reproduce side. The adjustment range of pot R 71 is adequate to set the cF values shown in the table for positive or negative frequency deviation. Calibration is accomplished by means of a frequency counter as described above. The internal reference can be used for positive signal voltages. With the attenuator switch in position zero, the cF coarse control is used to set the carrier frequency to the negative frequency deviation shown in the table according to the mode of operation desired. With the attenuator switch in position ΔF the frequency is set to plus deviation for the ΔF mode. (The reproduce side can be calibrated in the same operation via testing or via the tape, in accordance with the applicable operating instructions.)

For negative signal voltages an auxiliary voltage must be applied to the input and used to calibrate in the opposite direction of frequency deviation at the corresponding attenuator switch position (such as 1 V) and the zero position.

5-4. Repair

Repair of the unit should be attempted only by personnel experienced in printed writing techniques. Recommended repair is limited to the replacement of defective parts and adjustment of controls. When removing and replacing defective parts, care should be exercised so as not to damage surrounding components of the circuit board. Replacement parts must be of the correct type and value as listed in the parts list in Section VI. When

installing a new part, place it in the exact position of the replaced part. After replacement, carefully inspect the circuit board for evidence of cold solder joints, solder splashes and insecurity of mounting. If the equipment is repaired, the amplifiers should be checked and, if necessary, adjusted as described in adjustment procedures which are detailed in previous portions of this section.

5-5. Parts Identification

Components of the MC FM Record Amplifier are illustrated in Section VI of this manual showing locations and part designations. The parts list in Section VI itemizes the component parts in the assembly and provides a Bell & Howell part number for each.

5-6. Field Repair Service

Regular scheduled maintenance service is available from the Bell & Howell Instruments Division Sales and Service Office on a contract basis. If immediate service is required, it may be obtained on an emergency basis. Every effort is made to furnish the needed repair as soon as possible. For a complete description of Bell & Howell's maintenance service plans and their costs, contact the Instruments Division Sales and Service Office.

5-7. Factory Repair Service

If desired, instruments (or major assemblies) may be returned to the factory for repair. When an instrument or assembly is returned:

a) Indicate the symptom of defect. State as completely as possible, both on an instrument tag and on the order form, the nature of the problem encountered. Too much information is far better than too little. If the trouble is intermittent, please be specific in describing the instrument's performance history.

b) Give special instructions. If any changes in the instrument or assembly have been made, and it is desired to retain the modified form, please indicate this specifically.

c) State the desired invoicing procedure. In the first correspondence, indicate whether repair work may begin immediately with billing in accordance with the standard pricing system or whether Bell & Howell should secure prior approval of the price before proceeding with the repair. The price will be the same in both cases, but any delay will be minimized by permission to start work immediately. The order acknowledgement copy will, of course, always show the price.

d) Pack securely and label. Proper packaging saves money. The small amount of extra care and time it takes to cushion a part or instrument properly may prevent costly damage while in transit. Make certain that the address is both legible and complete; failure to do so often results in needless delay. Address all shipments and correspondence to the Bell & Howell Instruments Division Subsidiary the equipment was delivered from; attention: Service Department.

e) Show return address on repair correspondence. Please indicate clearly the exact address to which the equipment should be returned after repair is completed. All shipping costs will be borne by the owner of the equipment, not by Bell & Howell.

5-8. Recalibration of the Circuit Card after Repairing with Spare Parts

The reference (R 80) has been calibrated at the manufacturing plant. Recalibration, however, is necessary when replacing D 26 or IC 4, or components which are part of the reference. A digital voltmeter having an accuracy better than 0.1 % is required for this purpose. Following the repairs the tape unit with circuit card plugged in must have been operated for not less than eight hours, and at the time of calibration must have run at least 15 minutes at a room temperature of 25 ^{o}C. R 80 is used to select 5.000 V with an accuracy of $\pm$0.01 V on the TP 5. Subsequently, the remainder of the cicuit card must be recalibrated as necessary.

Replacing Parts in the VCO.

For this purpose only the original components must be used to ensure the retention of good temperature stability. When components have been replaced a cF and ΔF recalibration must be accomplished. If the calibration is not located within the previous range the components must be tested. Special attention must be devoted to the mica capacitors C 19/20/21/22. Any damage or modification, or any use of other makes, must be avoided.

Replacing IC 1

Special caution is indicated when working on MOS components, due to static charges. Following the replacement, the R6 offset potentiometer must be recalibrated. For this purpose the circuit card is plugged into the unit with the extender. The input is short-circuited. A voltmeter is used to measure the voltage on the hot end of R9 (ahead of the attenuator). R6 is used to calibrate zero voltage with an accuracy of $\pm$0.001 V.

After replacing IC 2,the R 13 offset potentiometer must be recalibrated. For this purpose the attenuator switch is set to zero and the circuit card is operated in the tape unit with an extender. A voltmeter is used to measure the voltage across TP 6. R6 is used to calibrate the zero voltage with an accuracy of ±0.001 V. With short-circuited input the attenuator is adjusted to a sensitivity of 0.1 V. The voltage across TP 6 is checked and a zero calibration made with an accuracy of ±0.02 V if necessary. When the attenuator is subsequently set to zero and a deviation from the first calibration is found,the offset calibration of the input amplifier must be checked.

Display Calibration

The circuit card is operated in the tape unit with extender. For this purpose it is necessary that all other calibration points are properly calibrated. The attenuator is set to +ΔF. Using R 104, the display is adjusted until the 100 % LED lights up. On circuit boards up to serial number 09010100 a fixed resistance is installed. The power supply of the voltage divider is obtained from the -15 V supply of the tape unit. After display repairs on the card the voltage divider is adjusted by changing the position of R 171 until, with attenuator setting +ΔF, the 100 % lamp lights up.

6. Parts List

6-1. General

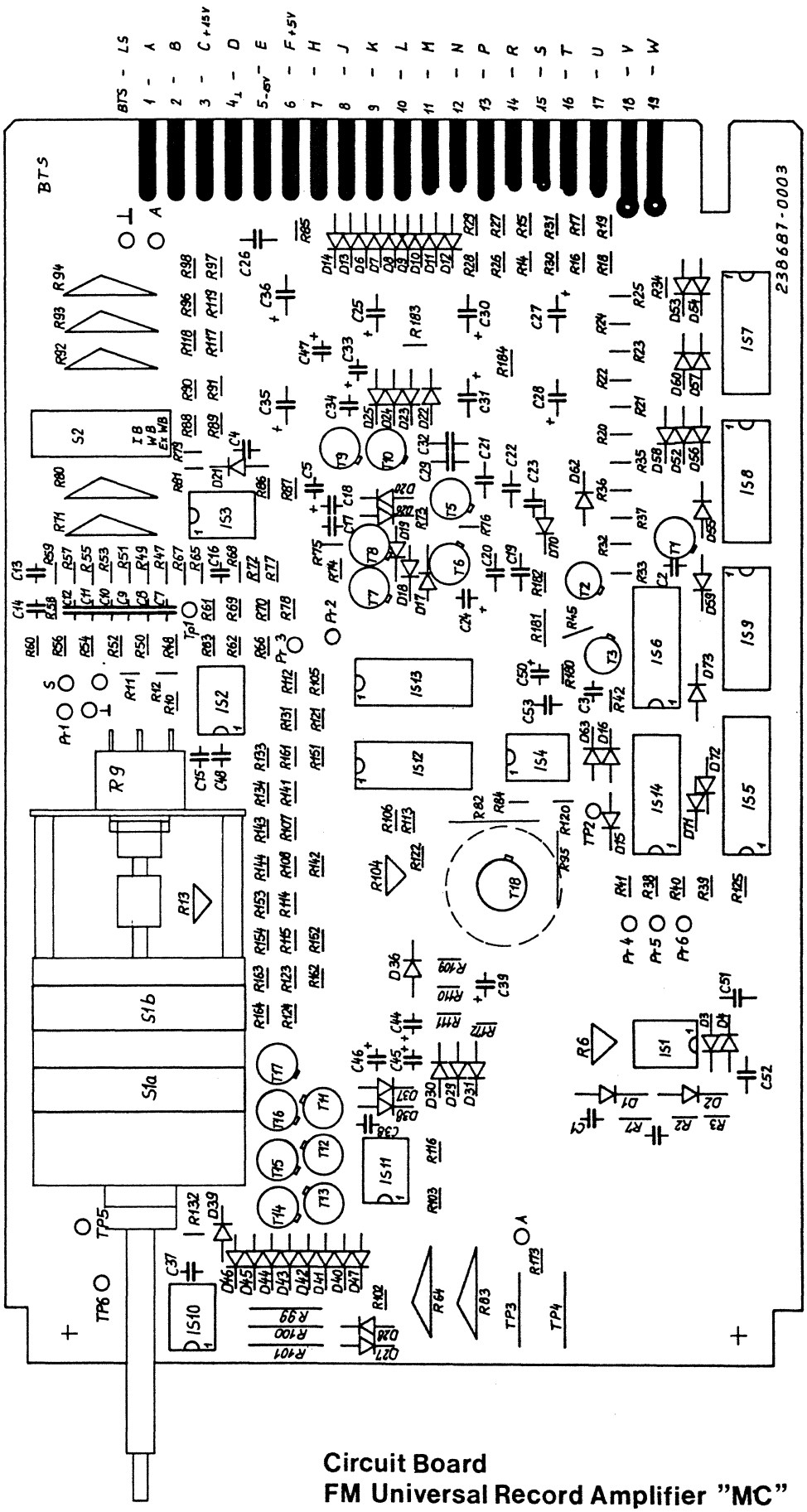
An appropriate parts list and illustration for the MC FM Record Amplifier follow the instructions given below. The parts list includes the Bell & Howell Instruments Division part number, description, figure and index and/or schematic reference symbol and, where applicable, the manufacturer's or military part number for each component.

6-2. Ordering Replacement Parts

Parts should be ordered through the nearest Bell & Howell Instruments Division Sales and Service Office. Price and delivery information on parts or complete instruments may be obtained there also. To assist in making this contact a list of Sales and Services Offices is included in the front of this manual. Bell & Howell recommends that whenever possible, and particularly when an instrument is used in a critical application, the user maintain a minimum stock of spare parts. Instruments Division has specialized personnel ready to assist the user in making a selection of spares at any time. The same personnel are also ready and able to prepare or quote on the preparation of illustrated parts breakdowns (IPS's), provisioning parts breakdowns (PPB's) and other parts documentation that might be required.

When ordering parts, the following information should always be supplied to the field office engineers:

a) A description of the part or assembly, obtained from the parts list.



Circuit Board
FM Universal Record Amplifier "MC"

b) The Bell & Howell part or assembly number, also on the parts list, or on the component itself.
c) The figure and index and/or reference symbol, given on the applicable diagram and on the parts list.
d) The part or type number of the major assembly, shown on the instrument nameplate.
e) The production serial number, also on the nameplate.
f) The Bell & Howell register number applying to the complete system or order.

238687

Wiring Diagram
FM Universal Record Amplifier "MC"

Assembly Sequence	Symbol	B & H Part-No.	Part Description	Manu-facturer	DIN	Quantity
..2	R19	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R20	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R21	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R22	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R23	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R24	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R25	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R26	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R27	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R28	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R29	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R30	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R31	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R91	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R12	236490-0122	R KO 1K2 SK2 0,25W 5%	RO/RE	N	1,000
..2	R60	236490-0122	R KO 1K2 SK2 0,25W 5%	RO/RE	N	1,000
..2	R35	236490-0153	R KO 15K SK2 0,25W 5%	RO/RE	N	1,000
..2	R109	236490-0181	R KO 180R SK2 0,25W 5%	RO/RE	N	1,000
..2	R85	236490-0220	R KO 22R 5K2 0,25W 5%	RO/RE	N	1,000
..2	R56	236490-0221	R KO 220R SK2 0,25W 5%	RO/RE	N	1,000
..2	R89	236490-0221	R KO 220R SK2 0,25W 5%	RO/RE	N	1,000
..2	R90	236490-0221	R KO 220R SK2 0,25W 5%	RO/RE	N	1,000
..2	R181	236490-0222	R KO 2K2 SK2 0,25W 5%	RO/RE	N	1,000
..2	R73	236490-0222	R KO 2K2 SK2 0,25W 5%	RO/RE	N	1,000
..2	R76	236490-0222	R KO 2K2 SK2 0,25W 5%	RO/RE	N	1,000
..2	R11	236490-0224	R KO 220K SK2 0,25W 5%	RO/RE	N	1,000
..2	R36	236490-0332	R KO 3K3 SK2 0,25W 5%	RO/RE	N	1,000
..2	R45	236490-0332	R KO 3K3 SK2 0,25W 5%	RO/RE	N	1,000
..2	R88	236490-0332	R KO 3K3 SK2 0,25W 5%	RO/RE	N	1,000
..2	R38	236490-0333	R KO 33K SK2 0,25W 5%	RO/RE	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.			Part Description	Manu-facturer	DIN	Quantity
.1		236288-	KABL	1P0	RG U 174 K0AX	A	N	300,000
.1		238469-	BG		screening plate compl.		N	1,000
..2		238289-	ME		screening plate		N 4	1,000
..2		280096-	ME		nut M 2		N	4,000
.1		238687-0100	BG	MC	front panel compl. FM mounting		N	1,000
..2		126732-0031	ST W 1	P0	BNC-socket KINGS KC-79-46 NEYE		N	1,000
..2		236987-	ME	LOES	loop 10,5		N	1,000
..2		238687-0110	ME	.....	front panel		N 4	1,000
..2		238687-0120	ME	MC	front panel from 238687-0121		N 4	1,000
.1		238687-0125	ME	MC	knob upper part		N 4	1,000
.1		238687-0126	ME	MC	knob lower part		N 4	1,000
.1		238687-0200	BG	MC	recording amplifier LP		N	1,000
..2		236235-0003	ME		nut M 3		N 4	2,000
..2	C35	236262-	C	EL	100U EK100-40V RM 5	R0	N	1,000
..2	C36	236262-	C	EL	100U EK100-40V RM 5	R0	N	1,000
..2	T1	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T11	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T12	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T13	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T14	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T15	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T16	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T17	236281-	T	N	BCY 58 D	IT	N	1,000
..2	T2	236281-	T	N	BCY 58 D	IT	N	1,000
..2	R183	236490-0010	R	K0	1R SK2 0,25W 5%	R0IRE	N	1,000
..2	R184	236490-0010	R	K0	1R SK2 0,25W 5%	R0IRE	N	1,000
..2	R97	236490-0101	R	K0	100R SK2 0,25W 5%	R0/RE	N	1,000
..2	R98	236490-0101	R	K0	100R SK2 0,25W 5%	R0/RE	N	1,000
..2	R117	236490-0102	R	K0	1K SK2 0,25W 5%	R0/RE	N	1,000
..2	R118	236490-0102	R	K0	1K SK2 0,25W 5%	R0/RE	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.	Part Description	Manufacturer	DIN	Quantity
..2	R119	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R120	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R48	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R50	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R61	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R96	236490-0102	R KO 1K SK2 0,25W 5%	RO/RE	N	1,000
..2	R108	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R111	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R115	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R124	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R134	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R144	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R154	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R164	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R172	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R32	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R66	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R69	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R70	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R87	236490-0103	R KO 10K SK2 0,25W 5%	RO/RE	N	1,000
..2	R107	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R114	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R123	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R133	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R14	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R15	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R16	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R17	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R18	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000
..2	R182	236490-0104	R KO 100K SK2 0,25W 5%	RO/RE	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.			Part Description		Manu-facturer	DIN	Quantity
..2	R40	236490-0333	R	KO	33K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R41	236490-0333	R	KO	33K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R54	236490-0391	R	KO	390R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R82	236490-0470	R	KO	47R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R180	236490-0471	R	KO	470R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R63	236490-0471	R	KO	470R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R110	236490-0472	R	KO	4K7	SK2 0,25W 5%	RO/RE	N	1,000
..2	R42	236490-0472	R	KO	4K7	SK2 0,25W 5%	RO/RE	N	1,000
..2	R86	236490-0472	R	KO	4K7	SK2 0,25W 5%	RO/RE	N	1,000
..2	R142	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R143	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R152	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R153	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R162	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R163	236490-0473	R	KO	47K	SK2 0,25W 5%	RO/RE	N	1,000
..2	R33	236490-0562	R	KO	5K6	SK2 0,25W 5%	RO/RE	N	1,000
..2	R37	236490-0680	R	KO	68R	SK2 0,25W 5%	RO1RE	N	1,000
..2	R52	236490-0681	R	KO	680R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R125	236490-0682	R	KO	6K8	SK2 0,25W 5%	RO/RE	N	1,000
..2	R34	236490-0682	R	KO	6K8	SK2 0,25W 5%	RO/RE	N	1,000
..2	R39	236490-0682	R	KO	6K8	SK2 0,25W 5%	RO/RE	N	1,000
..2	R173	236490-0820	R	KO	82R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R10	236490-0821	R	KO	820R	SK2 0,25W 5%	RO/RE	N	1,000
..2	R78	236490-0821	R	KO	820R	SK2 0,25W 5%	RO/RE	N	1,000
..2	C39	236493-	C	TA	1U	ETP 35V RM 2,5	RO	N	1,000
..2	C25	238654-1840	C	TA	47U	TAP 35V RM 5	IT	N	1,000
..2	C27	238654-1840	C	TA	47U	TAP 35V RM 5	IT	N	1,000
..2	C28	238654-1840	C	TA	47U	TAP 35V RM 5	IT	N	1,000
..2	C30	238654-1840	C	TA	47U	TAP 35V RM 5	IT	N	1,000
..2	C31	238654-1840	C	TA	47U	TAP 35V RM 5	IT	N	1,000

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..2	D22	238654-1956	D	1N 4148			
..2	D23	238654-1956	D	1N 4	IT/TX/V	N	,000
..2	D24	238654-1956	D	1N 41	IT/TX/V	N	000
..2	D25	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D27	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D28	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D29	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D3	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D30	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D31	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D36	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D37	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D38	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D4	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D52	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D53	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D54	238654-1956	D	1N 4148	IT/TX/V	N	1,000
..2	D55	238654-1956	D	1N 4148	IT/TX/V	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.			Part Description	Manu-facturer	DIN	Quantity
..2	D56	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D57	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D58	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D59	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D6	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D60	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D62	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D63	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D7	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D70	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D71	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D72	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D73	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D8	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	D9	238654-1956	D		1N 4148	IT/TX/V	N	1,000
..2	R6	238655-0603	PO	CE	10K 0650-310	RU	N	1,000
..2	C24	238658-0920	C	TA	0U47 ETP 35V RM 2,5	RO	N	1,000
..2	C33	238658-0920	C	TA	0U47 ETP 35V RM 2,5	RO	N	1,000
..2	S1	238687-0101	SCH	MC	2x10 switch positions	EBE	N 4	1,000
..2	D1	238687-0102	D		FD 300	FAIR	N	1,000
..2	D2	238687-0102	D		FD 300	FAIR	N	1,000
..2	D26	238687-0103	D	Z	1N825	V SESC	N	1,000
..2	D40	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D41	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D42	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D43	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D44	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D47	238687-0104	D	LED	LED CQX 11 2,54x5,08GRUEN	TEL	N	1,000
..2	D45	238687-0105	D	LED	LED CQX 12 2,54x5,08GELB	TEL	N	1,000
..2	D46	238687-0106	D	LED	LED CQX 10 2,54x5,08ROT	TEL	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.	Part Description	Manu-facturer	DIN	Quantity
..2	R9	238687-0107	POAT 2K2 LIN GH4G032P222UA	ALL BRADL	N	1,000
..2	C12	238687-0108	C KE 180P R0U700 63V RM 2,5	RE	N	1,000
..2	IS1	238687-0111	IC ALG CA 3140 T	RC	N	1,000
..2	IS6	238687-0112	IC DIG MC14013CP /CD4013BE	MO/RC	N	1,000
..2	IS12	238687-0113	IC ALG CA 324	RC	N	1,000
..2	IS13	238687-0113	IC ALG CA 324	RC	N	1,000
..2	T3	238687-0114	T N 2N 2369	IT	N	1,000
..2	T5	238687-0114	T N 2N 2369	IT	N	1,000
..2	T6	238687-0114	T N 2N 2369	IT	N	1,000
..2	R104	238687-0116	PO T CE 10K 850-208 +-10%	VI	N	1,000
..2	R13	238687-0116	PO T CE 10K 850-208 +-10%	VI	N	1,000
..2	T10	238687-0117	T N BSX49	S	N	1,000
..2	T9	238687-0117	T N BSX49	S	N	1,000
..2		238687-0401	ME MC SCHILD		N 4	1,000
..2		238688-0003	LP MC recording amplifier		N	1,000
..2	R80	239055-	POAT CE 2K 3009-P1-202	BOURNS	N	1,000
..2	R92	239055-	POAT CE 2K 3009-P1-202	BOURNS	N	1,000
..2	R93	239055-	POAT CE 2K 3009-P1-202	BOURNS	N	1,000
..2	R94	239055-	POAT CE 2K 3009-P1-202	BOURNS	N	1,000
..2		239162-	KK MT KK 20-10 FUER TO 5	AUST	N	1,000
..2	T7	239319-	T P BCY 78 D	IT	N	1,000
..2	T8	239319-	T P BCY 78 D	IT	N	1,000
..2	R83	239326-	POAT CE 500R 3009-P1-501	BOURNS	N	1,000
..2	TP1	239336-	ST M 1 PO NR.12610	GRO+HARTM	N	1,000
..2	TP2	239336-	ST M 1 PO NR.12610	GRO+HARTM	N	1,000
..2	TP5	239336-	ST M 1 PO NR.12610	GRO+HARTM	N	1,000
..2	TP6	239336-	ST M 1 PO NR.12610	GRO+HARTM	N	1,000
..2	C18	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000
..2	C44	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000
..2	C45	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.	Part Description	Manu-facturer	DIN	Quantity
..2	C46	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000
..2	C47	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000
..2	C50	239509-	C TA 4U7 ETP 25V RM 2,5	RO	N	1,000
..2	TP4	239549-	ST W 1 PO 2-582-118-0 SCHWARZ	AMP	N	1,000
..2	TP3	239550-	ST W 1 PO 2-582-118-2 ROT	AMP	N	1,000
..2	T18	239714-	T P BC 360-16 TO 39	IT	N	1,000
..2	R64	239824-	POAT CE 10K 3009-P1-103	BOURNS	N	1,000
..2	R71	239824-	POAT CE 10K 3009-P1-103	BOURNS	N	1,000
..2	S2	280035-	SCH SS DS16B2-4 M ABDECKH DIL 16	ADV	N	1,000
..2	IS14	280042-	IC DIG MC14011BCP /CD4011BE	MO/RC	N	1,000
..2	IS7	280042-	IC DIG MC14011BCP /CD4011BE	MO/RC	N	1,000
..2	IS8	280042-	IC DIG MC14011BCP /CD4011BE	MO/RC	N	1,000
..2	IS9	280042-	IC DIG MC14011BCP /CD4011BE	MO/RC	N	1,000
..2	IS5	280049-	IC DIG MC14040CP	MO	N	1,000
..2	R47	280052-1001	R MT 100R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R49	280052-1001	R MT 100R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R105	280052-1002	R MT 1K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R112	280052-1002	R MT 1K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R121	280052-1002	R MT 1K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R131	280052-1002	R MT 1K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R141	280052-1002	R MT 1K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R100	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R101	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R103	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R2	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R67	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R7	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R84	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R99	280052-1003	R MT 10K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R3	280052-1005	R MT 1M SMA0207 TK50 +-1%	DRA RE	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.			Part Description	Manu-facturer	DIN	Quantity
..2	R95	280052-1243	R	MT	12K4 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R62	280052-1333	R	MT	13K3 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R81	280052-1503	R	MT	15K SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R122	280052-1823	R	MT	18K2 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R65	280052-1823	R	MT	18K2 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R116	280052-2742	R	MT	2K74 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R72	280052-2742	R	MT	2K74 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R77	280052-2742	R	MT	2K74 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R79	280052-2742	R	MT	2K74 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R58	280052-2942	R	MT	2K94 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R51	280052-3011	R	MT	301R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R106	280052-3323	R	MT	33K2 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R113	280052-3323	R	MT	33K2 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R55	280052-4121	R	MT	412R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R151	280052-4991	R	MT	499R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R161	280052-4991	R	MT	499R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R53	280052-4991	R	MT	499R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R102	280052-4992	R	MT	4K99 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R132	280052-4992	R	MT	4K99 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R74	280052-5622	R	MT	5K62 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R75	280052-5622	R	MT	5K62 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R59	280052-5900	R	MT	59R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R57	280052-5901	R	MT	590R SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	R68	280052-6813	R	MT	68K1 SMA0207 TK50 +-1%	DRA RE	N	1,000
..2	C10	280059-	C	KE	220P R0U700 63V RM 2,5	RE	N	1,000
..2	C11	280059-	C	KE	220P R0U700 63V RM 2,5	RE	N	1,000
..2	C26	280063-	C	KE	0U01 RFO 600 32V RM 5	RE	N	1,000
..2	C29	280063-	C	KE	0U01 RFO 600 32V RM 5	RE	N	1,000
..2	C32	280063-	C	KE	0U01 RFO 600 32V RM 5	RE	N	1,000
..2	C53	280063-	C	KE	0U01 RFO 600 32V RM 5	RE	N	1,000

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Assembly Sequence	Symbol	B & H Part-No.			Part Description	Manu-facturer	DIN	Quantity
..2	C1	280071-	C	KE	1000P ROZ 63V RM 2,5	RE	N	1,000
..2	C2	280071-	C	KE	1000P ROZ 63V RM 2,5	RE	N	1,000
..2	C7	280071-	C	KE	1000P ROZ 63V RM 2,5	RE	N	1,000
..2	C8	280071-	C	KE	1000P ROZ 63V RM 2,5	RE	N	1,000
..2	C13	280074-	C	KE	33P ROP700 63V RM 2,5	RE	N	1,000
..2	C16	280074-	C	KE	33P ROP700 63V RM 2,5	RE	N	1,000
..2	C34	280074-	C	KE	33P ROP700 63V RM 2,5	RE	N	1,000
..2	C48	280075-	C	KE	68P ROP 63V RM 2,5	RE	N	1,000
..2	IS10	280111-	IC	ALG	RC 4531 DN	RC	N	1,000
..2	IS11	280111-	IC	ALG	RC 4531 DN	RC	N	1,000
..2	IS2	280111-	IC	ALG	RC 4531 DN	RC	N	1,000
..2	IS3	280111-	IC	ALG	RC 4531 DN	RC	N	1,000
..2	C9	280141-	C	KE	330P ROU 63V RM 2,5	RE	N	1,000
..2	IS4	280178-	IC	ALG	SN72558P MC1458N	TX MO	N	1,000
..2	C14	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C17	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C23	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C3	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C4	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C5	280182-	C	KE	0U01ROY700 63V RM 2,5	RE	N	1,000
..2	C15	280184-	C	KE	4P7 ROC700 63V RM 2,5	RE	N	1,000
..2	C19	280185-	C	GL	180P TYP4815+-5% 500VTKO	JAHRE	N	1,000
..2	C20	280185-	C	GL	180P TYP4815+-5% 500VTKO	JAHRE	N	1,000
..2	C21	280185-	C	GL	180P TYP4815+-5% 500VTKO	JAHRE	N	1,000
..2	C22	280185-	C	GL	180P TYP4815+-5% 500VTKO	JAHRE	N	1,000
..2	C51	280202-	C	KE	0U1 CKO5BX 104K 50V	RE	N	1,000
..2	C52	280202-	C	KE	0U1 CKO5BX 104K 50V	RE	N	1,000
..2	C37	280203-	C	KE	39P P1ROC700 63V RM 2,5	RE	N	1,000
..2	C38	280203-	C	KE	39P P1ROC700 63V RM 2,5	RE	N	1,000